

## **Integrating SPC and TPM**

### **1. Introduction**

An important continuous improvement tool for manufacturing organizations is Total Productive Maintenance (TPM). Although both TPM and SPC are continuous improvement techniques it is normally not perceived that they have the same goals. What is commonly perceived is: The original goal of total productive management: *“Continuously improve all operational conditions, within a production system; by stimulating the daily awareness of all employees”* (by Seiichi Nakajima, Japan, JIPM)

An accurate and practical implementation of TPM, will increase productivity within the total organization, where :

- (1) .. a clear business culture is designed to continuously improve the efficiency of the total production system
- (2) .. a standardized and systematic approach is used, where all losses are prevented and/or known.
- (3) .. all departments, influencing productivity, will be involved to move from a reactive- to a predictive mindset.
- (4) .. a transparent multidisciplinary organization is reaching zero losses.
- (5) .. steps are taken as a journey, not as a quick menu.

The Deming-method to plan, do, check , act and the underlying idea of people empowerment at the shop floor are present in both the TPM and SPC approach. For analyzing special causes of variation similar techniques are applied like FMEA, Pareto analysis, etc. The organizational structure to improve also shows great similarities between the two systems. The major difference is that TPM puts a lot of emphasis on quick change over (Single Minute Exchange of Dies (SMED)) and maintenance and SPC puts a lot of emphasis on improving critical quality characteristics as requested by customers. A second big differences seems to be the way data is gathered and reported. In TPM OEE data is reported and in SPC control charts and capability reports are made.

So in theory implementing a continuous improvement program which integrates both methods can be very rewarding for companies.

In this document we will show how SPC methods will help to improve OEE analysis and show how OEE analysis and reports are integrated in DataLyzer.

## 2. OEE ratios

There is no standardization for OEE definitions. There are some attempts to standardize (see for example <http://oeeindustrystandard.oeefoundation.org>). DataLyzer is setup very flexible so you can use your own categories and definitions.

To calculate the OEE of a machine or process we start with the total time. This 24 hours x 7 days a week

**Total time**

From this total time the time no production is scheduled needs to be subtracted. Examples of no production scheduled are for example no production during the weekend, no orders, no production due to overcapacity, holidays, strike etc.

**Planned production time**

**Non scheduled time**

The planned production time is the starting point for the OEE calculations. The OEE is the multiplication of 3 ratios. The availability, the performance and the quality. So  $OEE = \text{availability} \times \text{performance} \times \text{quality}$ .

### Availability

The availability is the ratio between operating time and total planned production time.

**Operating time**

**Downtime losses**

The 3 big losses in downtime loss are :

- change over and setup
- breakdowns of the machine
- waiting time

### Performance

The performance ratio is the net operating time / operating time.

**Net operating time**

**Speed loss**

The 2 big losses in speed loss are:

- Small stops
- Reduced speed

The difference between small stops and a breakdown is the amount of time the machine is stopping. With a small stop the machine normally doesn't stop. Examples are a blocked cavity or a jam in packaging so one or 2 places stay empty. With small stops the production can be started almost instantly again.

## Quality

The quality ratio is the productive time / net operating time.



The 2 big losses in quality loss are:

- Production rejects
- Startup rejects

OEE = Availability \* Performance \* Quality

To improve the net productive time the OEE ratios need to be improved or the scheduled down time needs to be decreased.

### 3. OEE integrated in DataLyzer Spectrum SPC module

The definition of the OEE ratios is pretty clear but measuring the different ratios is not always so easy. Measuring the total speed loss is more or less possible but it is not always easy to determine which part of the speed loss is caused by small stops and which part is caused by running with reduced speed. If all information is available in the PLC of the machine the information can be extracted and the different ratios can be calculated in detail. But even if we don't have a PLC connection we still can get a very good estimate of the OEE factors and get the right information to drive the improvement process.

In DataLyzer Spectrum the OEE registration can be setup easily by using categories, attribute control charts and optional parameters.

If you create an OEE category group DataLyzer will automatically create 4 categories for this group.

- Planned downtime
- Unplanned downtime
- Performance Loss
- Quality Loss

You can add new categories and assign the category to one of the 4 loss types.

Category	Order	Limit	Sampling Plan Size	Acceptance Number	Upper Reasonable Limit	UCL	OEE - Loss Type
Unscheduled	1	180	960	240		180	Shutdown loss
Downtime	2	90	960	135		60	Downtime loss
Waiting time	3	20	960	50		60	Downtime loss
Line restraint time	4	30	960	50		60	Downtime loss
Performance loss time	5	30	960	45		30	Performance Loss

Figure 1: Categories for OEE calculation

We can set (statistical) limits per category and the categories which are not of the shutdown loss type are used for the OEE calculation. Limits can be set per shift or can be set for aggregated time periods.

Data input for OEE analysis and reporting can be done automatically by using the DataLyzzer real-time OEE module or manually at the end of a shift.

In figure 2 the data entry screen is given in case data entry is done manually. Relevant data will be entered or calculated based on optional parameter values entered.

[Category] Loss	Minutes
[Waiting time] Planned maintenance	0
[Unscheduled downtime] No orders	0
[Waiting time] No personnel	25
[Unscheduled downtime] No material	0
[Unscheduled downtime] Pause	0
[Downtime] Breakdown cause 1	15
[Downtime] Breakdown cause 2	0
[Downtime] Breakdown cause 3	0
[Waiting time] Change over	0
[Waiting time] Setup machine	0
[Performance loss time] Stoppage cause 1	0
[Performance loss time] Stoppage cause 2	0

Parameter	Value
Machine rate	10
Parts produced	4800
Parts rejected productio	0
Parts rejected startup	0

Total Loss: 40  
 Total Production Time: 480  
 Loss Proportion: 0.083  
 OEE: 91.67%

Figure 2: Input screen OEE data

#### 4. Real-time OEE

For real-time OEE DataLyzer works closely together with the number #1 OEE software supplier FullFact.

The FullFact OEEBlue software is a flexible real-time module that can accommodate OEE varying from manual downtime registration to full data collection from machines through optical sensors, serial hardware connection devices, ethernet software and hardware tools and OPC to obtain production information from your equipment. Data from heterogeneous machines can be integrated providing a plant-wide single interface, dashboard and reporting OEE and SPC system. FullFact OEE software seamlessly integrates with the DataLyzer SPC system helping it to reap the enormous benefits of both TPM and SPC as continuous improvement techniques offering one user interface for the operator

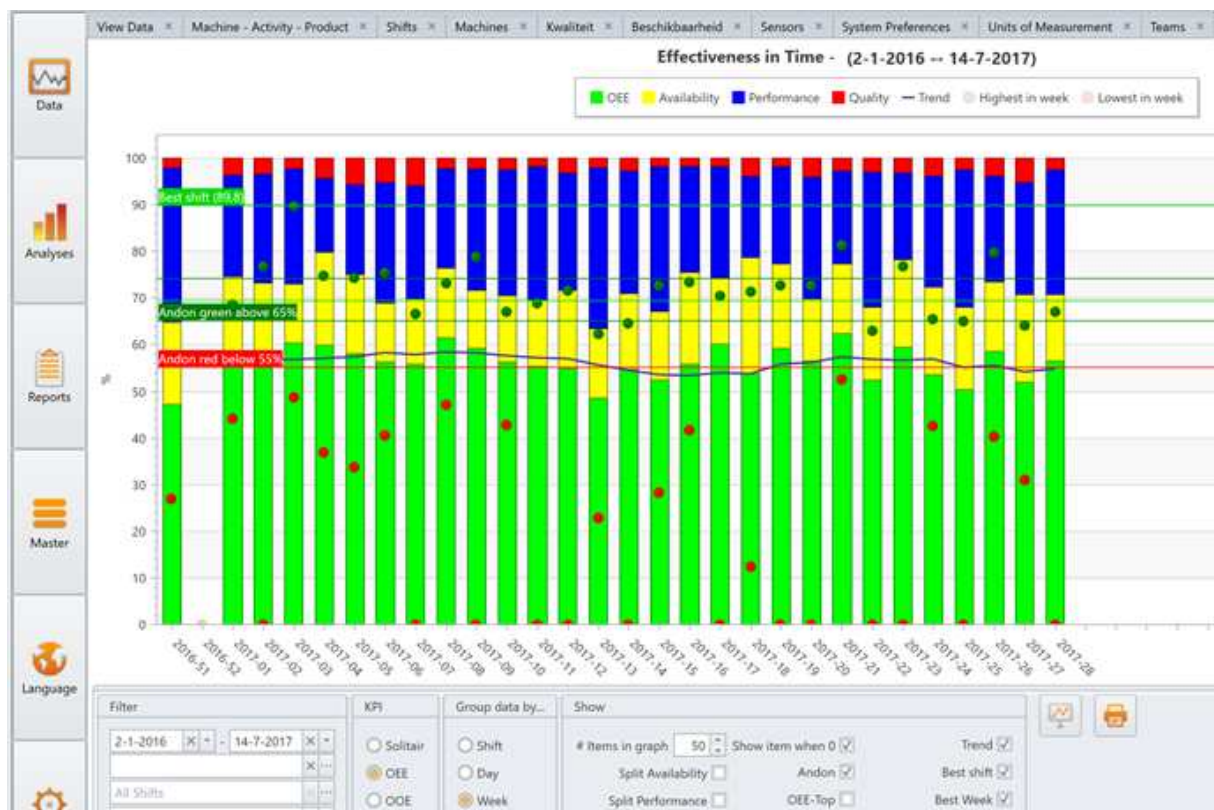


Figure 3: FullFact real-time OEE software

FullFact is 30 years in business and offers a complete solution for every production situation.

## 5. Advantages integrating SPC and OEE

In most production situations you have a combination of OEE and SPC requirements. Some examples

### *Food industry:*

You want to apply OEE on a production line but you also need to measure the weight of the products every 20 minutes. The advantage of an integrated approach is that the OEE system can trigger the weight measurement based on the right business rules.

### *Injection moulding industry*

You need to perform quality measurements on the product preferable per cavity and the tool should be able to handle blocked cavities, but you also want to perform OEE and want to have an analysis if downtimes are influencing the product quality.

Process characteristics might offer an early warning system for downtimes. If the cycle time is going to vary this might lead to downtimes. An integrated SPC and OEE solution can provide the tools to analyze correlations between process characteristics and production downtimes.

### *Automotive industry*

An OEE system is essential to push for very reliable lead times with the lowest cost. At the same time the customer requires to perform SPC measurements according to the control plan eg every 5th product and provide capability reports according to TS16949 requirements.

The integrated DataLyzer/FullFact solution can easily offer this functionality

### *Pharmaceutical industry*

TO optimize usage of resources more and more pharmaceutic industries are applying OEE but at the same time they need to perform quality measurements and comply with CFR 21 Part 11 regulations.

The DataLyzer/FullFact combination has all knowledge in house to offer all of this in their standard solution

Integrating the two approaches in one improvement approach and using an integrated software solution has advantages:

- Productivity and quality will be equally important and the company will truly benefit if both are improved.
- The methodology for continuous improvement will be accepted quicker if both methods are integrated and supported by one approach and an integrated software solution.
- When companies use both methods time required for training, system support and system maintenance is reduced.

## 6. Contact

For further information contact DataLyzer International:

### Europe

DataLyzer International bv  
Eindhoven  
Netherlands  
Tel : +31-40-2940980  
Email: [sales@datalyzer.com](mailto:sales@datalyzer.com)

### USA

DataLyzer International Inc.  
Wixom, MI 48393, USA  
Tel : +1-248-960-3535  
Tel : 800-553-4772 USA only  
Email: [sales@datalyzer.com](mailto:sales@datalyzer.com)

### Asia

DataLyzer India  
Bangalore  
India  
Tel: + 91 8026615292  
Email: [salesindia@datalyzer.com](mailto:salesindia@datalyzer.com)