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 difference 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

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.

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 = availability x performance x quality.

Availability

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

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.

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.

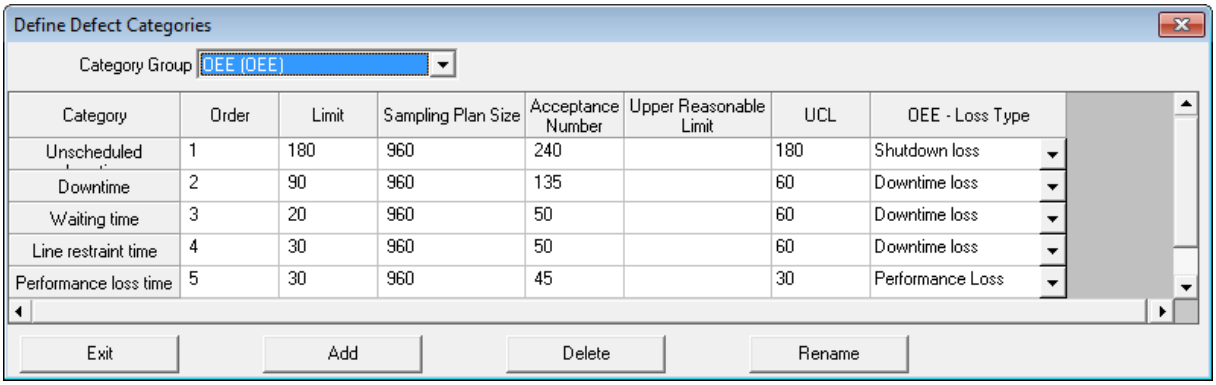

Figure 1: Categories for OEE calculation

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 DataLyzer 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.

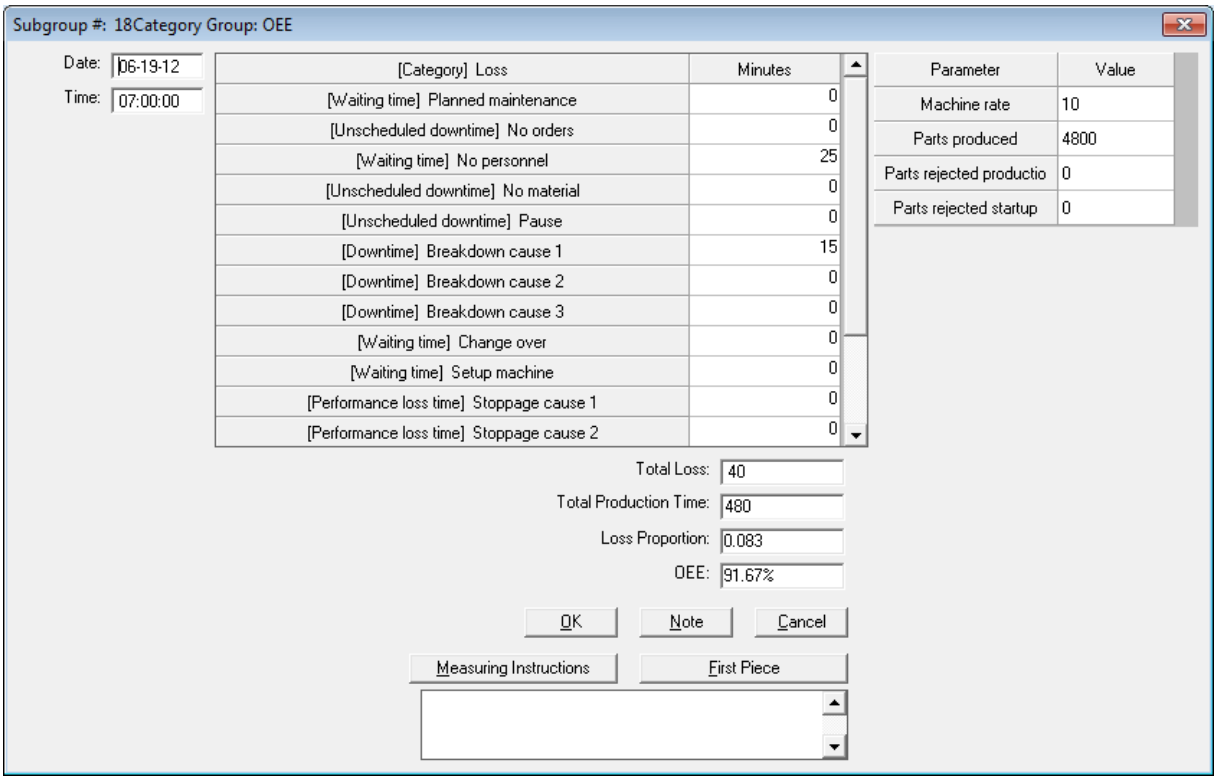

Figure 2: Input screen OEE data

4. Real-time OEE

For real-time OEE DataLyzer delivers OEE Coach.

The OEE Coach 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. OEE Coach 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

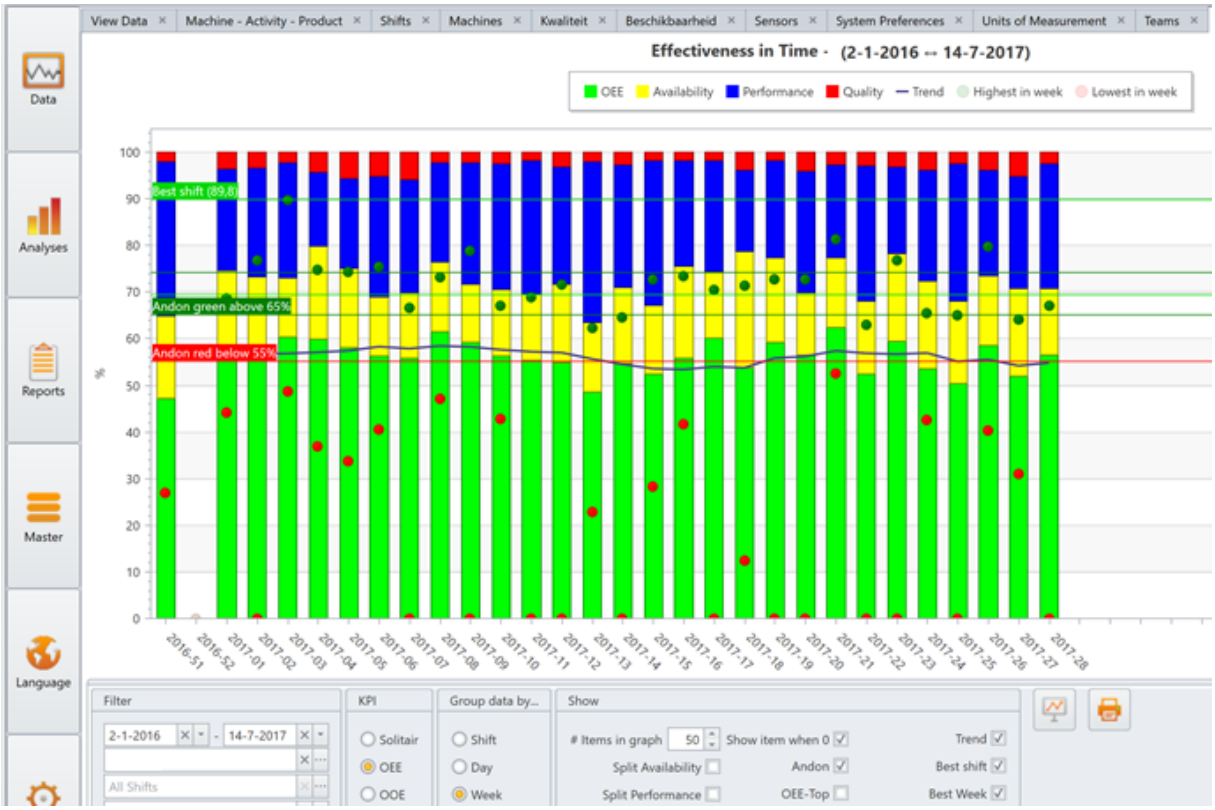

Figure 3: OEE Coach software

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.

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